A Miniature Multimodal Imaging System for Medical Diagnostics and Interventions in Space

Completed Technology Project (2014 - 2018)

Project Introduction

Long-term health of astronauts in space relies on effective in-situ diagnoses, management and interventions. However, clinicians are not always present during space exploration. Furthermore, the constraints of space travel make it difficult to bring large scanners such as magnetic resonance imaging (MRI) and X-ray computed tomography (CT) to space. Ultrasound is small and compatible with space exploration. However, ultrasound suffers from a small field of view, and ultrasound images are not easily correlated with anatomical structures, making it difficult to use for astronauts. Recently, significant efforts have been directed towards optical modalities, such as fluorescence imaging, due to their high sensitivity and small size. Miniature imaging systems that can combine the advantages of several modalities will be beneficial for clinical use in space. For effective deployment in space, an imaging system must be accurate, small, safe and easy to use, providing for in-situ diagnosis and treatment assistance. To facilitate long-term health management in space, we propose to develop a prototype miniature multimodal imaging goggle device for guiding medical examinations and interventions during space exploration. We will adapt the imaging goggle concept for aerospace use and expand the present goggle system by integrating multiple imaging modalities, including pre-flight MRI and real-time ultrasound, with the goggle. The 3D multimodal images will be processed, co-registered and displayed in the goggle eyepieces in real-time. The project will be guided by three specific aims: (1) develop a prototype goggle device that can offer fluorescence imaging and wireless communication capacity, (2) integrate MRI and ultrasound with fluorescence imaging, and (3) use multimodal imaging goggle to guide medical examinations and interventions by first responders. With the versatile multimodal imaging goggle at astronauts☐ disposal, wide arrays of medical procedures in space can be enabled. Local and space-earth collaborations can be established to guide various procedures. Minimal medical training will be needed for operating the system owing to its user-friendliness. The proposed multimodal goggle will revolutionize long-duration health management by enabling astronauts to perform complex image-guided examinations and interventions in space. The proposed academic and research program will offer me comprehensive training in aerospace-related bioengineering research, which bridges the gap between medicine and space. I will have opportunities for training in a new research setting that involves multiple disciplines, including medical imaging, aerospace engineering, optical instrumentation, emergency clinical care and translational research. Such experience will not only augment my expertise in biomedical and aerospace instrumentation but also will enhance my vision in interdisciplinary innovative research. Utilizing close collaborations with top aerospace technology researchers and clinicians, I will be able to integrate my capacity in bioengineering with my knowledge in aerospace technology to solve clinical challenges in space. The visiting technologist experience will further sharpen my perception in long-duration health management from an aerospace perspective. Furthermore, the collaborative nature of the proposed training will inspire me to develop

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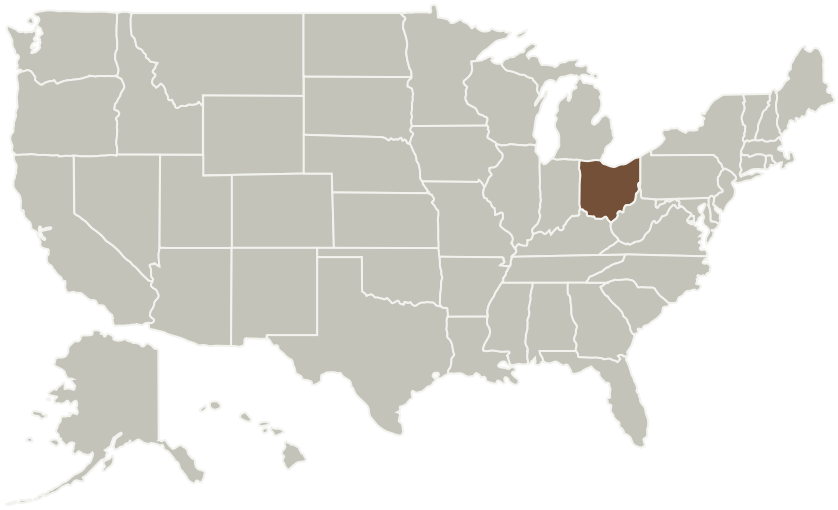
management and leadership skills, which will greatly benefit my future career as a researcher who leads a multidisciplinary team solving aerospace-related bioengineering problems.

Anticipated Benefits

Miniature imaging systems that can combine the advantages of several modalities will be beneficial for clinical use in space.

Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of Akron Main Campus	Lead Organization	Academia	Akron, Ohio

Primary U.S. Work Locations
Ohio

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html

Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Lead Organization:

University of Akron Main Campus

Responsible Program:

Space Technology Research Grants

Project Management

Program Director:

Claudia M Meyer

Program Manager:

Hung D Nguyen

Principal Investigator:

Yang Liu

Co-Investigator:

Christopher A Mela

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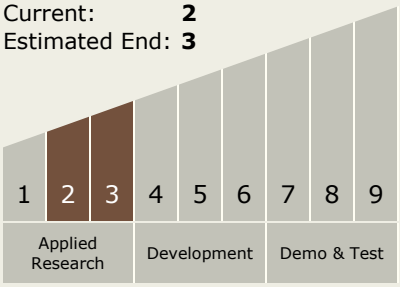
Technology Maturity (TRL)

Start: **2**
Current: **2**
Estimated End: **3**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.1 Medical Diagnosis and Prognosis

Target Destinations

Earth, The Moon, Mars